Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.


# Supporting Information

# Metal organic framework-derived Fe/C Nanocubes toward efficient microwave absorption

Rong Qiang,[a] Yunchen Du,[a, b, c] * Hongtao Zhao,[c, d] Ying Wang,[a] Chunhua Tian,[a] Zhigang Li,[c, d] Xijiang Han[a] * and Ping Xu[a, c] *

[a] Department of Chemistry, Harbin Institute of Technology, Harbin 150001,China.

E-mail:pxu@hit.edu.cn; hanxijiang@hit.edu.cn; yunchendu@hit.edu.cn

[b] State Key Laboratory of Urban Water Resource and Environment, School of Municipal and Environmental Engineering, Harbin Institute of Technology, Harbin 150001, China

[c] HIT-HAS Laboratory of High-Energy Chemistry and Interdisciplinary Science, Harbin Institute of Technology, Harbin 150001, China

[d] Institute of Technical Physics, Heilongjiang Academy of Sciences, Harbin 150009, China

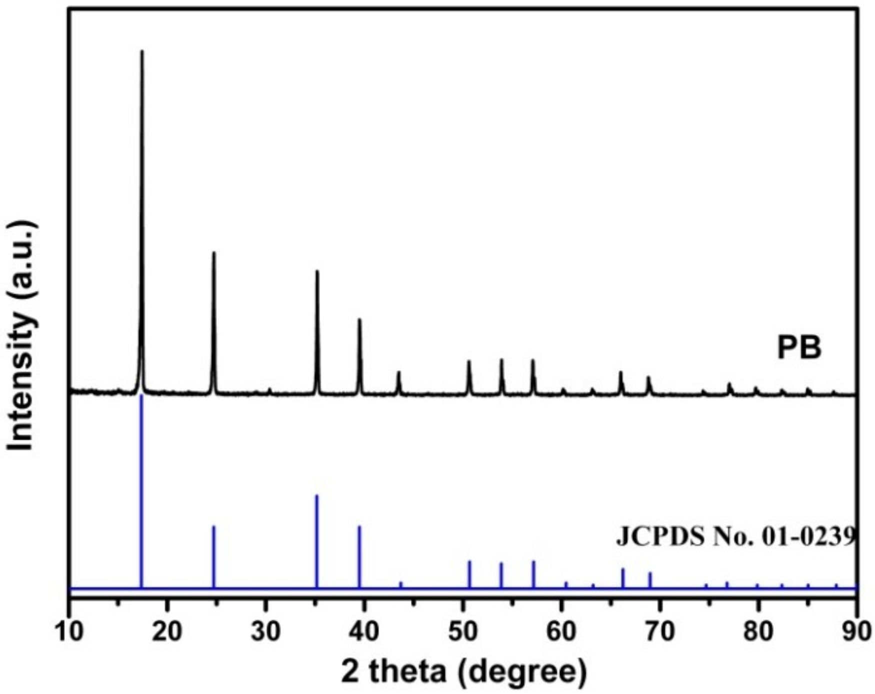


Figure S1 XRD patterns of as-prepared precursor and standard Prussian blue.

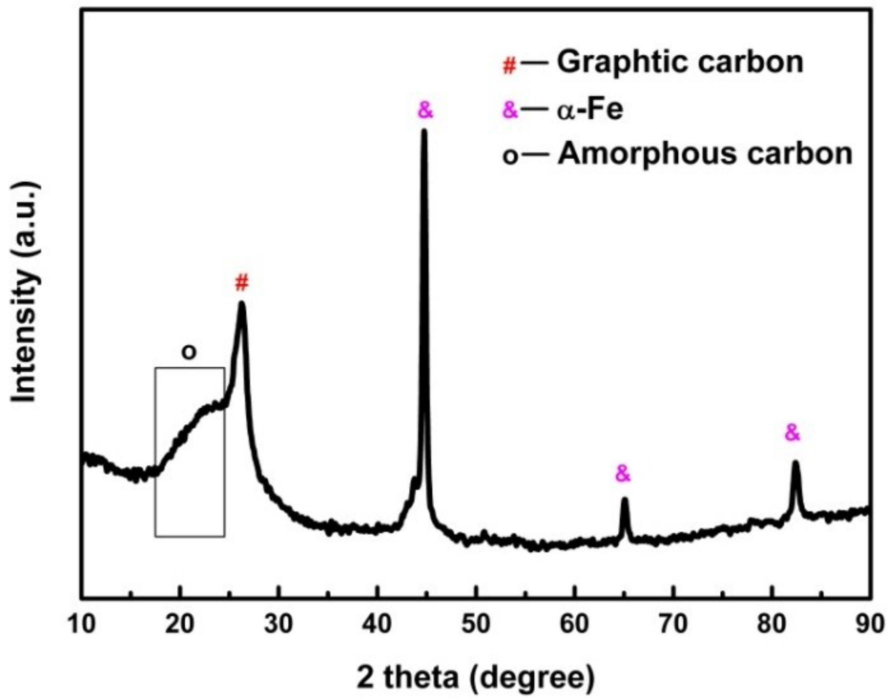


Figure S2 XRD pattern of Fe/C nanocubes after strong acid treatment.

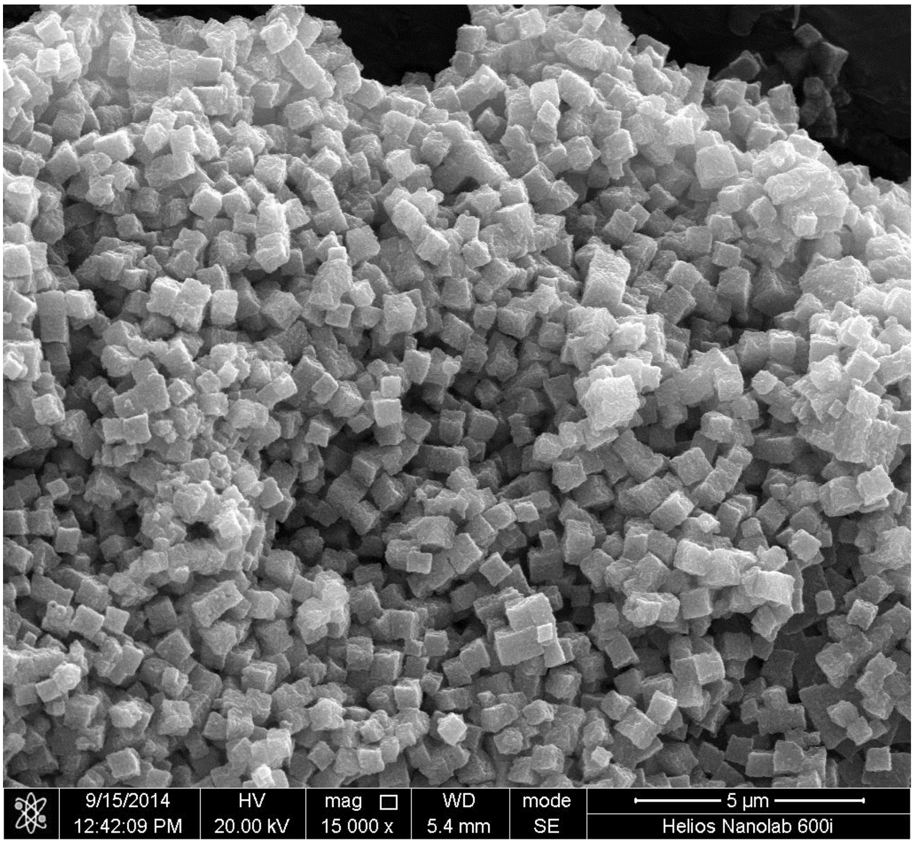


Figure S3 Low-magnification SEM image of S2.

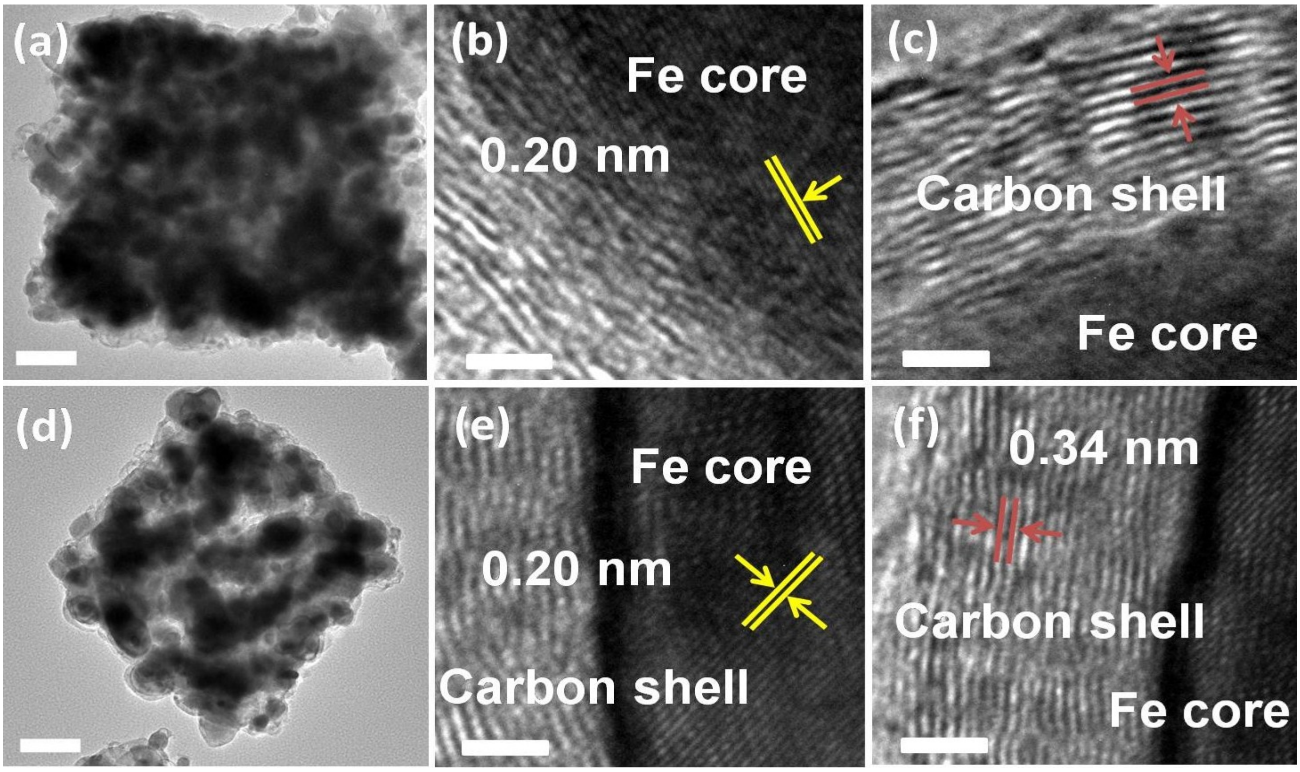


Figure S4 TEM images of S1 (a-c) and S3 (d-f).

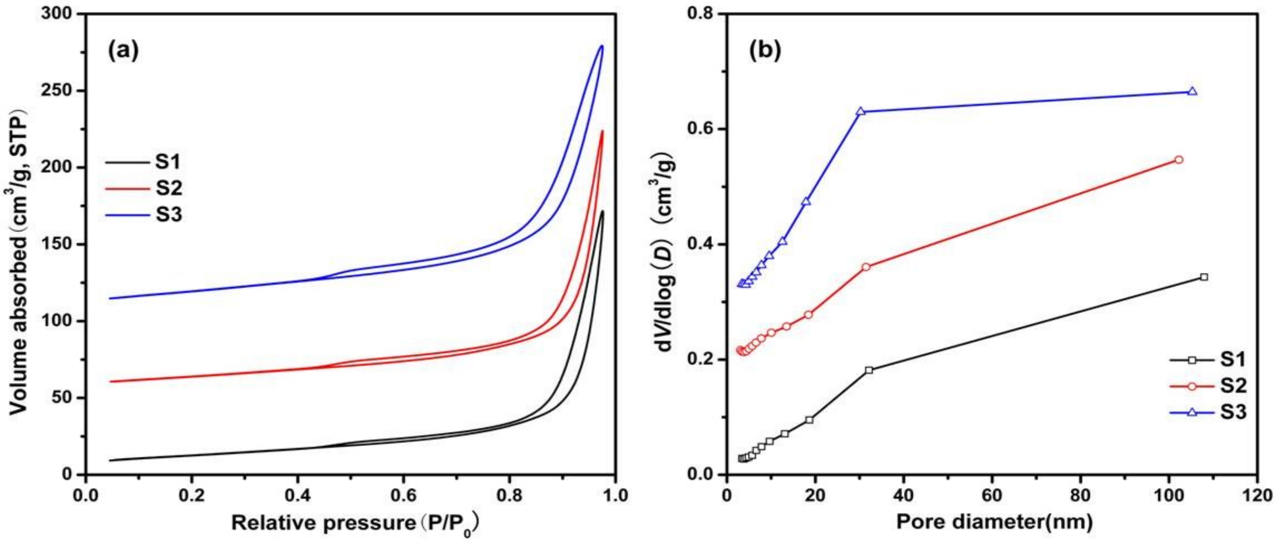


Figure S5 $N_2$ adsorption-desorption isotherms (a) and pore size distributions (b) of Fe/C composites. The isotherms of S2 and S3 remove upwards 50 and 100 cm3/g at the beginning for clarity, respectively.

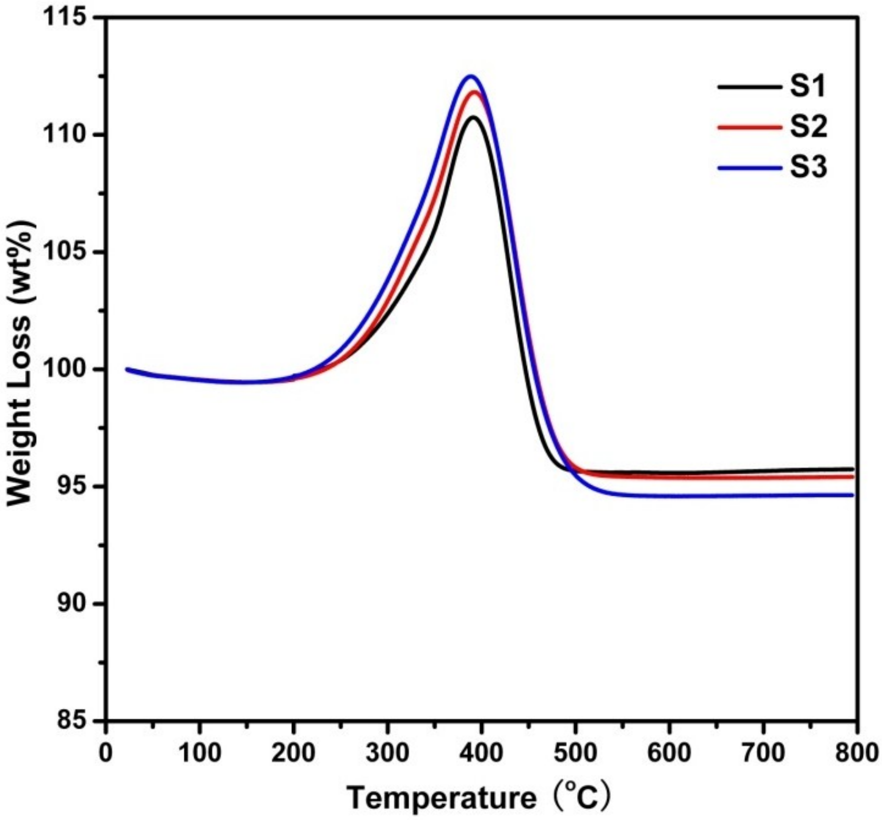


Figure S6 TG curves of various Fe/C composites.

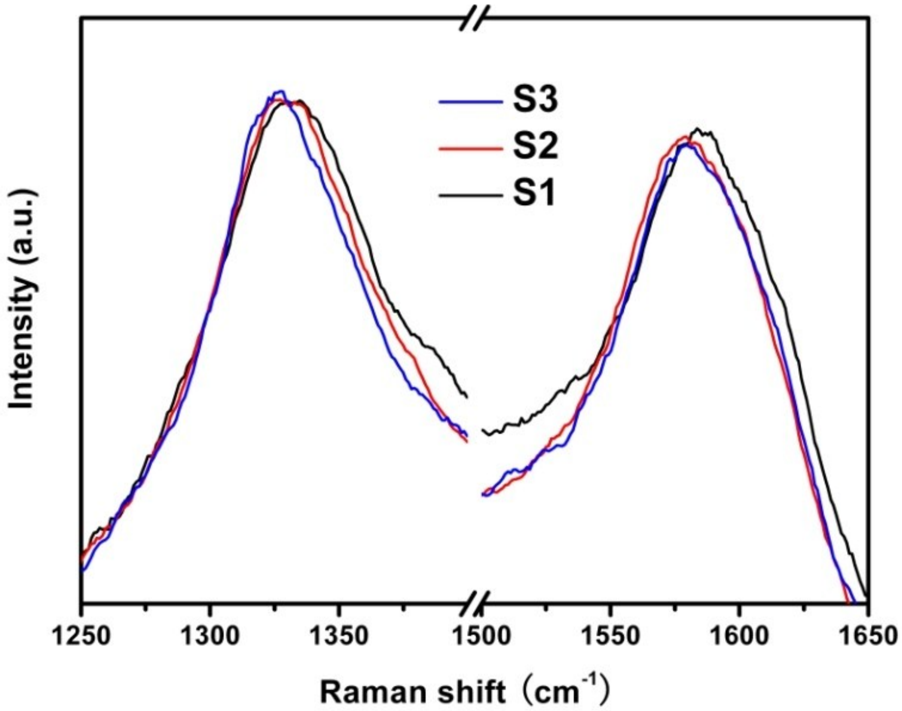


Figure S7 The local enlargements for D- and G-bands in Raman spectra.

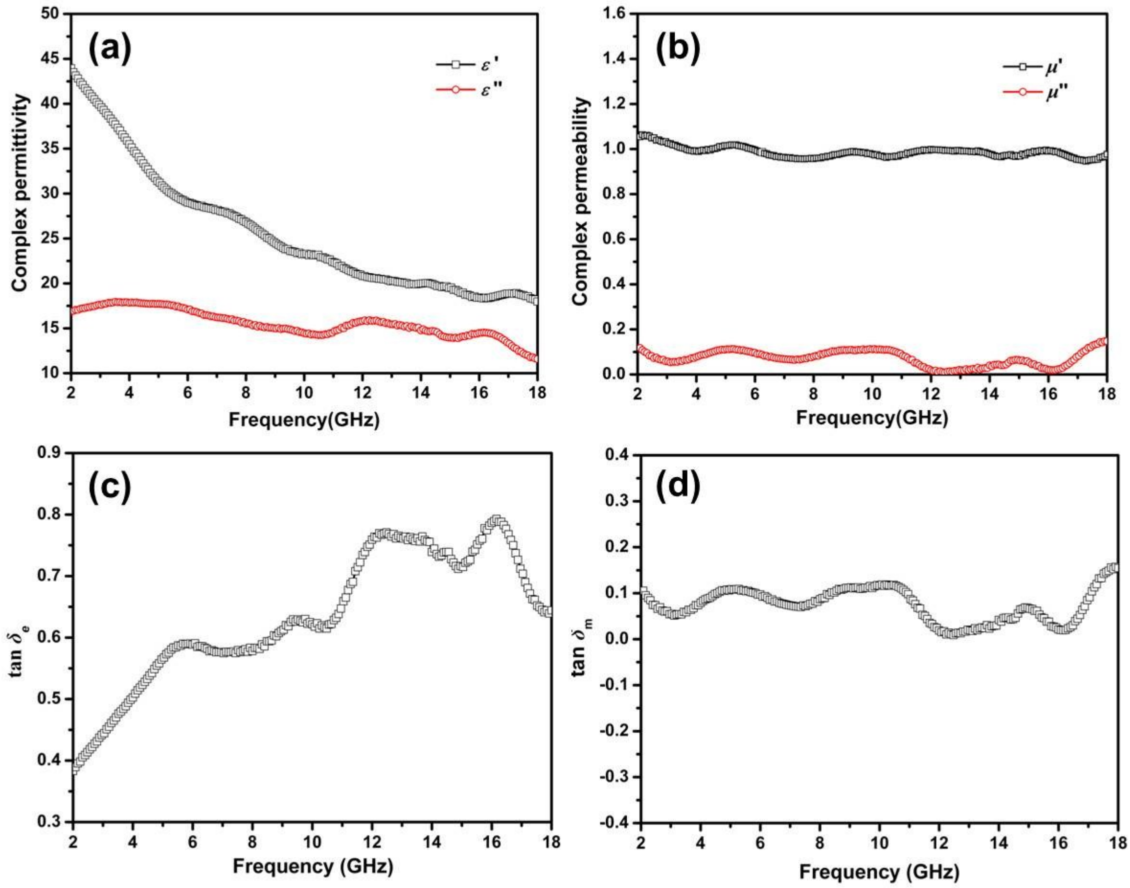


Figure S8 The complex permittivity (a), complex permeability (b), dielectric loss tangent (c) and magnetic loss tangent (d) of S2 after being treated by strong acid.

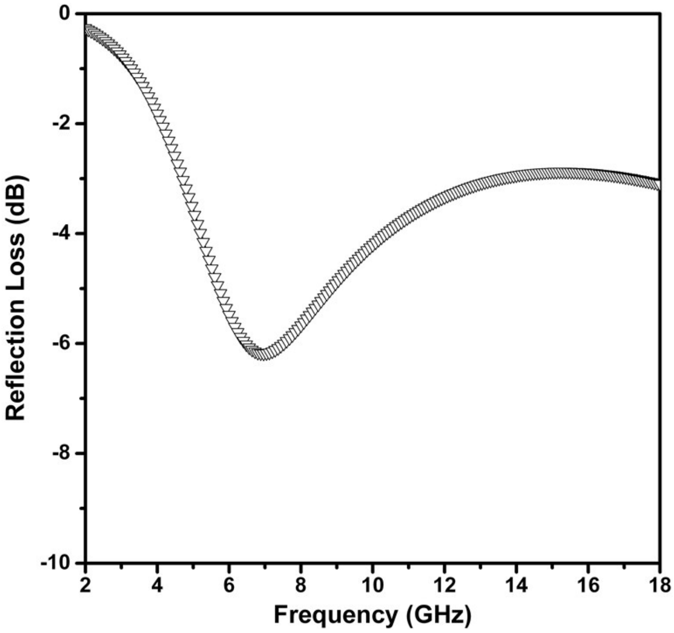


Figure S9 The reflection loss of S2 after being treated by strong acid.

Table S1 Textural and magnetic parameters for various Fe/C composites.

| Sample | BET ($m^2/g$) | Pore volume ( $cm^3/g$ ) | *M*s (emu/g) | *M*r (emu/g) | *H*c (Oe) |
|---|---|---|---|---|---|
| S1 | 45.7 | 0.32 | 121.0 | 20.6 | 442 |
| S2 | 50.0 | 0.32 | 118.7 | 17.1 | 383 |
| S3 | 69.8 | 0.30 | 106.6 | 13.4 | 335 |

Table S2 Microwave absorbing properties of various composites of carbon and magnetic metals in previous references and this work.

| Sample | Thickness (mm) | Bandwidth -10 dB (Range, GHz) | Integrated thickness (mm) | Bandwidth over -10 dB (Range, GHz) | Ref. |
|---|---|---|---|---|---|
| CoNi@C | 2.0 | 5.2 (12.8-18.0) | 2.0-4.8 | 13.9 (4.1-18) | 1 |
| porous carbon/Co | 1.8 | 2.2 (12.0-14.2) | 1.8-5.0 | 10.3 (3.8-14.1) | 2 |
| α-Fe/C | 2.1 | 3.3(5.2-8.5) | 1.8-3.3 | 8.4 (3.5-11.9) | 3 |
| h-Ni/GN | 2.0 | - | 2.0-5.5 | 4.0 (3.0-7.0) | 4 |
| | | | | 5.2 (11.9-17.1) | |
| FeNi/C | 2.0 | 2.9 (7.1-10.0) | 2.0-3.5 | 8.9 (9.1-18) | 5 |
| FeNi@C | 2.0 | 2.5 (13-15.5) | 2.0-5.0 | 5.6 (2.0-7.6) | 6 |
| | | | | 2.9 (10.8-13.7) | |
| CNF-Fe | 2.0 | 7.3 (7.9-15.2） | 2.5-5.0 | 12.2 (3.0-15.2) | 7 |
| Ni/C | 2.0 | 4.2 (11.2-15.4） | 2.0-5.0 | 10.8 (3.4-14.2) | 8 |
| Ni/MWCNT | 2.0 | 3.7 (12.3-16.0） | 2.0-5.3 | 12.0 (4.0-16.0) | 9 |
| Fe-C Nanofiber | 2.0 | 1.6 (6.2-7.8） | 2.0-3.5 | 4.7 (3.1-7.8) | 10 |
| Fe/GN | 2.0 | 4.4 (9.6-14.0） | 2.0-4.0 | 9.8 (4.2-14.0) | 11 |
| (Fe, Ni)/C | 2.0 | 5.5 (12.5-18.0） | 1.5-2.1 | 6.0 (12.0-18.0) | 12 |
| FeCo@C | 2.0 | 5.0 (7.0-12.0) | 2.0-4.0 | 13.9 (2.6-16.5) | 13 |
| $Fe_{60}Co_{40}$/C | 2.0 | 5.0 (9.5-14.5) | 2.0-4.5 | 11.8 (3.4-15.2) | 14 |
| $FeNi_3$@C | 2.0 | 4.6 (8.7-13.3) | 2.0-5.5 | 6.6 (3.2-9.8) | 15 |
| Fe/MWCNT | 5.5 | 2.0 (18.0-20) | 3.0-5.0 | - | 16 |
| Fe/Mesoporous carbon | 2.0 | 4.9 (11.4-16.3) | - | - | 17 |
| $Fe/Fe_3C$-MWCNT | 2.0 | 2.2 (8.1-10.3) | 2.0-3.5 | 6.6 (3.9-10.5) | 18 |
| NiFe/CNF | 2.0 | 3.8 (8.2-12) | - | - | 19 |
| Ni/GN | 2.0 | 3.8 (14.2-18) | - | - | 20 |
| Fe-filled CNTs | 2.5 | 0.8 (10.2-11) | - | - | 21 |
| $Ni_{1-x}Co_xP$/CNTs | 2.5 | 1.8 (7.0-8.8) | - | - | 22 |
| FeCoNi alloy/CNTs | 2.0 | 5.6 (12.4-18) | - | - | 23 |
| Fe/C | 2.0 | 7.2 (10.8-18.0) | 2.0-5.0 | 14.6 (3.4-18) | herein |


1 H. Wang, Y. Dai, W. Gong, D. Geng, S. Ma,; D. Li, W. Liu and Z. Zhang, *Appl. Phys. Lett.*, 2013, **102** , 223113.

2 Q. Liu, D. Zhang and T. Fan, *Appl. Phys. Lett.*, 2008, **93**, 013110.

3 J. R. Liu, M. Itoh, T. Horikawa, K.-i Machida, S. Sugimoto and T. Maeda, *J. Appl. Phys.*, 2005, **98**, 054305.

4 T. Chen, F. Deng, J. Zhu, C. Chen, G. Sun, S. Ma and X. Yang, *J. Mater. Chem.*, 2012, **22**, 15190.

5 X. G. Liu, Z. Q. Ou, D. Y. Geng, Z. Han, J. J. Jiang, W. Liu and Z. D. Zhang, *Carbon*, 2010, **48**, 891-897.

6 C. Feng, X. Liu, Y. Sun, C. Jin and Y. Lv, *RSC Adv.*,2014, **4**, 22710.

7 J. Xiang, J. Li, X. Zhang, Q.Ye, J. Xu and X. Shen, *J. Mater. Chem. A*, 2014, **2**, 16905-16914.

8 X. F. Zhang, X. L. Dong, H. Huang, Y. Y. Liu, W. N. Wang, X. G. Zhu, B. Lv, J. P. Lei and C. G. Lee, *Appl. Phys. Lett.*, 2006, **89**, 053115.

9 G. Tong, F. Liu, W. Wu, F. Du and J. Guan, *J. Mater. Chem. A*, 2014, **2**, 7373.

10 T. Wang, H. D. Wang, X. Chi, R. Li and J. B. Wang, *Carbon*, 2014, **74**, 312-318.

11 X. Zhao, Z. Zhang, L. Wang, K. Xi, Q. Cao, D. Wang, Y. Yang and Y. Du, *Sci Rep*, 2013, **3**, 3421.

12 X. G. Liu, B. Li, D. Y. Geng, W. B. Cui, F. Yang, Z. G. Xie, D. J. Kang and Z. D. Zhang, *Carbon*, 2009, **47**, 470-474.

13 S. S. S. Afghahi and A. Shokuhfar , *J. Magn. Magn. Mater.*, 2014, **370**, 37-44.

14 J. J. Jiang, X. J. Li, Z. Han, D. Li, Z. H. Wang, D. Y. Geng, S. Ma, W. Liu and Z. D. Zhang, *J. Appl. Phys.*, 2014, **115**, 17A514.

15 Y. Sun, X. Liu, C. Feng, J. Fan, Y. Lv, Y. Wang and C. Li, *J. Alloy. Compd.*, 2014, **586**, 688-692.

16 Q. He, T. Yuan, X. Zhang, X. Yan, J. Guo, D. Ding, M. A. Khan, D. P. Young, A. Khasanov, Z. Luo, J. Liu, T. D. Shen, X. Liu and S. Wei, Z. Guo, *J. Phys. Chem. C*, 2014, **118**, 24784-24796.

17 J. Zhou, J. He, G. Li, T. Wang, D. Sun, X. Ding, J. Zhao and S. Wu, *J. Phys. Chem. C*, 2010, **114**, 7611-7617.

18 P. Xu, X. J. Han, X. R. Liu, B. Zhang, C. Wang and X. H. Wang, *Mater. Chem. Phys.*, 2009, **114**, 556-560.

19 K.Y. Park, J.H. Han, S.B. Lee, J.B. Kim, J.W. Yi and S.K. Lee, *Compos. Sci. Technol.*, 2009, **69**, 1271-1278.

20 H. T. Zhao, Z. G. Li, N. Zhang, Y. C. Du, S. W. Li, L. Shao, D. Y. Gao, X. J. Han and P. Xu, *RSC Adv.*, 2014, **4**, 30467-30470.

21 H. Zhu, H. Lin, H. Guo and L. Yu, *Mater. Sci. Eng. B*, 2007, **138**, 101-104.

22 Y. Li, C. Zhu and C. Wang, *J. Phys. D-Appl. Phys.*, 2008, **41**, 125303.

23 R. Lv, F. Kang, J. Gu, X. Gui, J. Wei, K. Wang and D. Wu, *Appl. Phys. Lett.*, 2008, **93**, 223105.